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(71) Applicant: **Otkrytoe Aktsionernoe Obschestvo 'Bulanashskii Mashzavod'**
Sverdlovskaya obl. 623794 (RU)

(72) Inventors:
- **GAZAROV, Rudolf Ervandovich**
  Moscow, 117525 (RU)
- **SIDORENKO, Oleg Yakovlevich**
  Moscow, 107061 (RU)

(74) Representative: **Sloboshanin, Sergej et al**
V. Füner, Ebbinghaus, Finck, Hano
Mariahilfplatz 3
81541 München (DE)

(54) MULTIPLUNGER HORIZONTAL SINGLE-ACTING PUMP

(57) The invention relates to pump engineering, in particular to pumps for pumping aggressive fluids and can be used in hydrometallurgy, in the oil-and-gas, metal mining, coal and metallurgical industries. The aim of said invention is to ease and accelerate a pump assembling process. The inventive multiplunger horizontal single-acting pump comprises a drive part, for providing plungers with a reciprocating motion, and a hydraulic part provided with seals which embrace the plungers and are located in bushings. Each bushing is provided with radial channels, for supplying a lubricant to the plunger seal and for draining it therefrom, and an annular flange. One end face of said annular flange of the bushing is sunk into the housing boring of one of the pump parts, and the opposite end face thereof is located in the jointing plane of the housings of the drive and hydraulic parts, wherein the end face on the side of hydraulic part is sealed by means of a seal ring. The invention is **characterised in that** each flange is provided with two symmetrical vertical flattenings which are located at a distance equal to or less than the center-to-center spacing of the plungers. The distance between the flattenings of the adjacent flanges, which is specified by a fit tolerance, is a necessary condition for exactly positioning the bushings. The contacting flattenings of the adjacent flanges prevent the bushing, in which the channels for supplying and draining a lubricant permanently take a design position, from being turned.

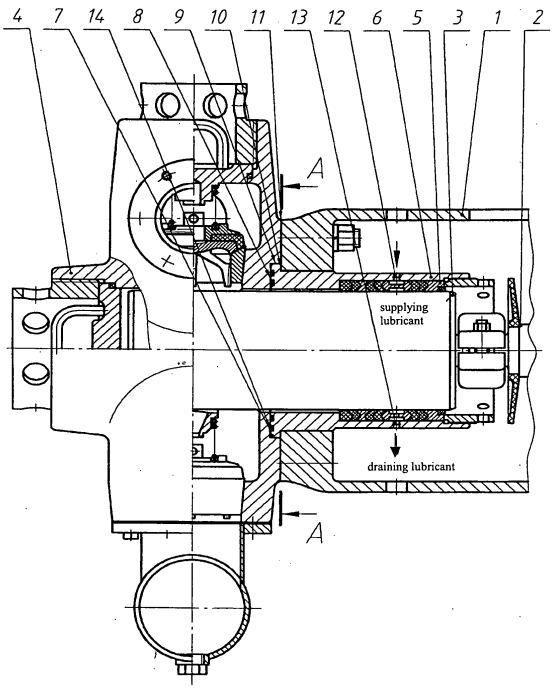

Fig. 1

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Description

[0001] The invention relates to pump engineering, in particular to pumps for pumping aggressive fluids.

[0002] The pump can be used in hydrometallurgy for pumping hot alkali-rich bauxite slurry in the production of alumina, in the oil-and-gas industry for cementation, hydraulic cracking, supplying mud to the bottom of a borehole in the process of making test and exploitation boreholes and doing maintenance on them on the land and in the sea, metal mining, coal and metallurgical industries for pumping slurry, and also in forging and pressing equipment for pumping technical water in pumping and accumulation works of heavy hydraulic presses.

[0003] Two-plunger double-acting drilling pumps are known, for example the pump UNB-600 (U8-6MA2), which is most widely used in this country, and also the pump UNB-750 (U8-7MA2) of the same type (1. V.A. Lesetsky, A.L. Il'sky: Burovye mashiny i mekhanismy (Drilling Machines and Mechanisms); Moscow, Nedra 1980, pp. 206-207, drawing VII.7. 2. N.A. Severinchik: Mashiny i oborudovanie dlya bureniya skvashin (Machines and Equipment for Drilling Boreholes); Moscow, Nedra 1986, p. 338, drawing 113. 3. R.A. Bagramov: Burovye mashiny I kompleksy (Drilling Machines and Units); Moscow, Nedra 1988, p. 251, drawing XIV.5). The hydraulic cells of the hydraulic part of these pumps are centered with the base of the drive part by means of a bushing with annular flanges, the outer faces of which are sunk in the borings of the hydraulic cells, while the inner ones are arranged in the vertical plane of the joint. The hydraulic cells are tightened to the base by bolts and nuts forming a rigid connection of the metal-in-metal type. The bushings are not secured against rotation during assembly and are not sealed in the hydraulic part, since this is not necessary: They are provided exclusively for centering.

[0004] A three-plunger pump for a hydraulic cracking and maintenance service of the boreholes is, for example, the domestically produced pump 4R-700 (1. E.S. Ibragimov, V.G. Gorbov, V.F. Seryakov: Nasosnyi agregat 4AN-700 dlya gidravlicheskogo razryva plastov I gidropeskostruynykh protsessov (Pumping Assembly 4AN-700 for Hydraulic Cracking of Strata and Hydraulic Sandblasting Processes); RNTS VNIIOENG, Machines and Oil Production Equipment series, 1963, Nr. 12, pp. 9-14. 2. A.G. Molchanov, L.G. Chicherov: Neftepromyslovye mashiny I mekhanismy (Oil Field Machines and Mechanisms); Moscow, Nedra 1976, p. 321. 3. E.I. Bukhalenko, V.V. Vershkovoy, Sh.T. Dshafarov et al.: Neftepromyslovoe oborudovanie (Oil Field Equipment). Moscow, Nedra 1990, p. 258.) The pump comprises a drive part transmitting a reciprocal movement to the plungers, and a hydraulic unit comprising the plunger seals arranged in the bushings. The drive part and the hydraulic unit are tightened by bolts and nuts. The bushings are provided with annular flanges with a thread and are screwed in with their outer faces into the borings of the hydraulic unit, while the inner ones are arranged in the vertical plane of the joint of the hydraulic unit and the drive base forming a rigid connection. They are sealed in the hydraulic unit by annular resin collars arranged in annular slots, comprise couplings for supplying lubricant to the friction surface of the plunger and the sealing. To ensure that the couplings are arranged in the predetermined (upper) position, the pump is preliminarily assembled marking the places of their positions for drilling the openings. During the final assembly of the pump the bushings are fixed in the upper position of the couplings by means of nuts and countemuts with a M1 90x3 thread.

[0005] The correct positioning of the couplings is achieved by carrying out a series of additional operations: the preliminary assembly, the marking of the places of their positions and the subsequent disassembling. The fastening of the bushings during the final assembly is labour-intensive (large dimensions of the nuts and countemuts). The bushings cannot be interchangeable.

[0006] The American pumps of the company Armco Steel Corp. (US Patents No 3276390, No 3891356) are more modem ones. The bushings of these pumps with outer annular flanges are sunk with their inner faces in the borings of the drive, while the outer faces lie in the plane of the joint of the hydraulic unit and the drive forming a rigid metal-in-metal connection. The bushings in the hydraulic unit are sealed with annular elastic seals. They are not secured against rotation during assembly, which makes an exact positioning of the lubricant channels impossible.

[0007] The multi-plunger horizontal single-action pump according to US Patent No 3276390, USPC 92-61, application date December 16, 1964, publication date October 4, 1966, can be considered the most pertinent prior art. The pump comprises a drive part transmitting a reciprocal movement to the plungers, and a hydraulic part with sleeves embracing the plungers, which are placed in the bushings. The latter are assembled in the borings of the base of the drive part and comprise outer annular flanges arranged between the shoulders of the base and abutting with their front surfaces on the plane of the hydraulic part. The front surfaces of the flanges have annular slots in which the seals for sealing the bushings in the hydraulic part are placed. Then bushings have channels for supplying pumped lubricant fluid to the friction surface of the plunger and the sleeve, the excess fluid being supplied to the couplings through drainage channels and subsequently being returned into the hydraulic part through pipes.

[0008] A shortcoming of the most pertinent prior art is the lack of means for fastening the bushings in the predetermined position of their lubricant channels. In connection with a possible rotation of the bushings during assembly, an incorrect position of the couplings makes the mounting of the pipes for the return of the liquid into the hydraulic part difficult, requiring their individual adjustment.

[0009] The object of this invention is to render the as-

sembly of the pump easier and quicker.

[0010] The object is achieved as follows. A multi-plunger horizontal single-action pump comprises a drive part transmitting a reciprocal movement to plungers, and a hydraulic part with seals surraounding the plungers, which seals are arranged in the bushings. Each bushing comprises radial channels for supplying lubricant to the seal of the plunger and its drain, and also an annular flange. One end face of the annular flange of the bushing is sunk in a boring of a housing of one of the parts of the pump, while the opposite face is arranged in the plane of the joint of the housings of the drive part and the hydraulic part, the end face being sealed from the side of the hydraulic part by an annular seal. What is new is that each flange comprises two symmetrical vertical flattenings, the distance between which does not exceed the distance between the axes of the plungers, that is, the distance between the flattenings of the flange corresponds to the distance between the axes of the plungers of the pump. A necessary condition for an exact fastening of the bushings is the distance between the flattenings of adjacent flanges specified by the fit tolerance. Flattenings of adjacent flanges in contact with each other prevent a rotation of the bushings, therefore their lubricant supply and drainage channels occupy a permanent position during assembly and operation of the pump.

[0011] Fig. 1 shows an overall view of the pump, Fig. 2 shows a section along the line A-A of Fig. 1.

[0012] An example is the three-plunger horizontal single-action pump comprising a drive part 1 transmitting a reciprocal movement by means of rods 2 to plungers 3, and also a hydraulic part 4 with seals 5 surrounding the plungers 3. The seals 5 are arranged in bushings 6 with annular flanges 7, the outer faces 8 of which are sunk in borings 9 of the hydraulic part 4. The opposite (inner) faces 10 of the flanges 7 are located in the plane of the joint 11 of the drive part 1 and the hydraulic part 4, tightened by fastening means forming a rigid connection of the metal-in-metal type. In the cylindrical part of the bushings 6, vertical channels 12 for supplying lubricant to the friction surface between the seal and the plunger and drainage channels 13 for excess amounts for the couplings of the pipes of the lubricant system (not shown in the drawings) are arranged diametrically opposed. The bushings 6 are sealed in the hydraulic part 4 by elastic rings 14 arranged in annular slots. The flanges 7 comprise two symmetrical vertical flattenings 15 each, fixing the bushings 6 in a vertical position of their channels 12 and 13. The distance B between the flattenings of each flange (Fig. 2) does not exceed the distance between the axes of the plungers A within the limits of fit tolerance during assembly.

[0013] The assembly of the pump is carried out in one stage by installing the elements and units in the hydraulic 4 and the drive 1 part, which are centred by the bushings 6 of the plungers 3. Thereby, the contacting flattenings 15 of the neighbouring flanges 7 mount the bushings 6 in a position excluding their rotation around their own axis and relative to each other, wherein their drainage channels 12 and 13 are always in one position. Therefore, it is not necessary to carry out prior assembly with marking of positions of the channels on the bushings and subsequent disassembly for drilling of apertures for the connecting pipe of the lubrication system, which must have a design position suitable for assembling. The assembly is completed by drawing together the casings of the drive and the hydraulic parts by fastening means: studs and screw-nuts.

[0014] The technical result to be achieved consists of the following:

- The channels for supplying lubricant to the seals of the plunger and its drainage during assembly always occupy the same position and their connection with the lubricant system is essentially simplified by the use of pipe assemblies manufactured beforehand in accordance with the planned dimensions without on-site adjustment ;
- the use of any device for fastening the bushings in the planned position of the channels in the assembly process and in the assembled pump is excluded;
- the assembly of the pump with the bushings needing a fixed position of their channels is not more difficult than the assembly of the pump with the channels being in any position or without them;
- the bushings of the plungers are completely interchangeable, which also simplifies the manufacturing and the repair of the pump.

[0015] The invention proposed for protection is included in the draft of construction documents of a series of comparable types of plunger slurry pumps NPG-Q-P with an intensive supply of lubricant by hydraulic protection according to USSR Invention No 1312245 provided for a continuous supply of hot raw bauxite slurry into leaching autoclaves in alumina production in the Bogoslov aluminium production plant.

Claims

1. A multi-plunger horizontal single-action pump comprising a drive part transmitting a reciprocal movement to plungers and a hydraulic part with seals surrounding the plungers and located in bushings, each of which comprises radial channels for supplying and draining lubricant, and also an annular flange, one end face of which is sunk in a boring of a housing of one of the parts while the other is located in the plane of the joint of the housings of the drive part and the hydraulic part, **characterized in that** the flange is provided with two symmetrical vertical flattenings located at a distance which does not exceed the distance between the axes of the plungers.

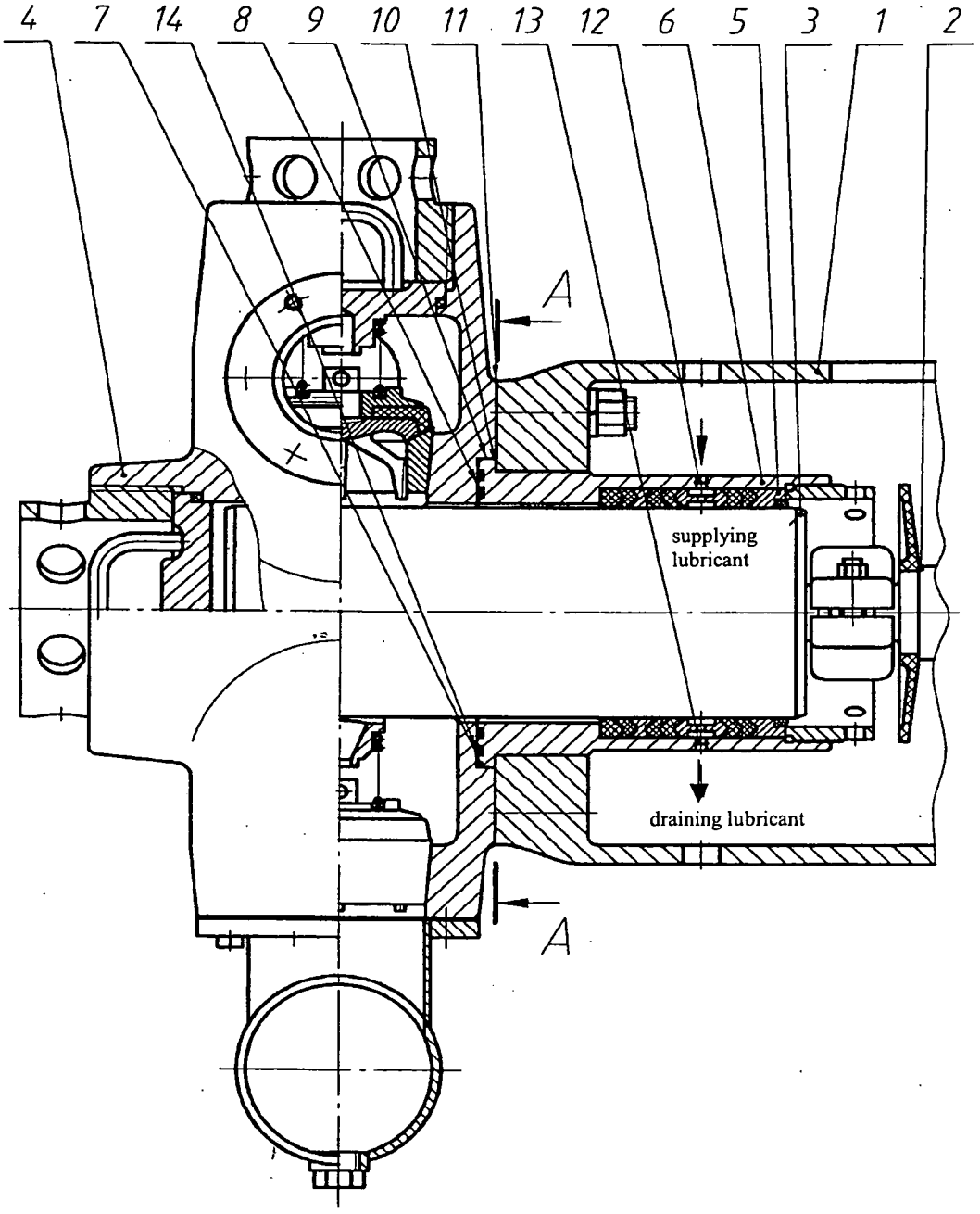
4
7
14
8
9
10
11
13
12
6
5
3
1
2
A
supplying lubricant
draining lubricant
A

Fig. 1

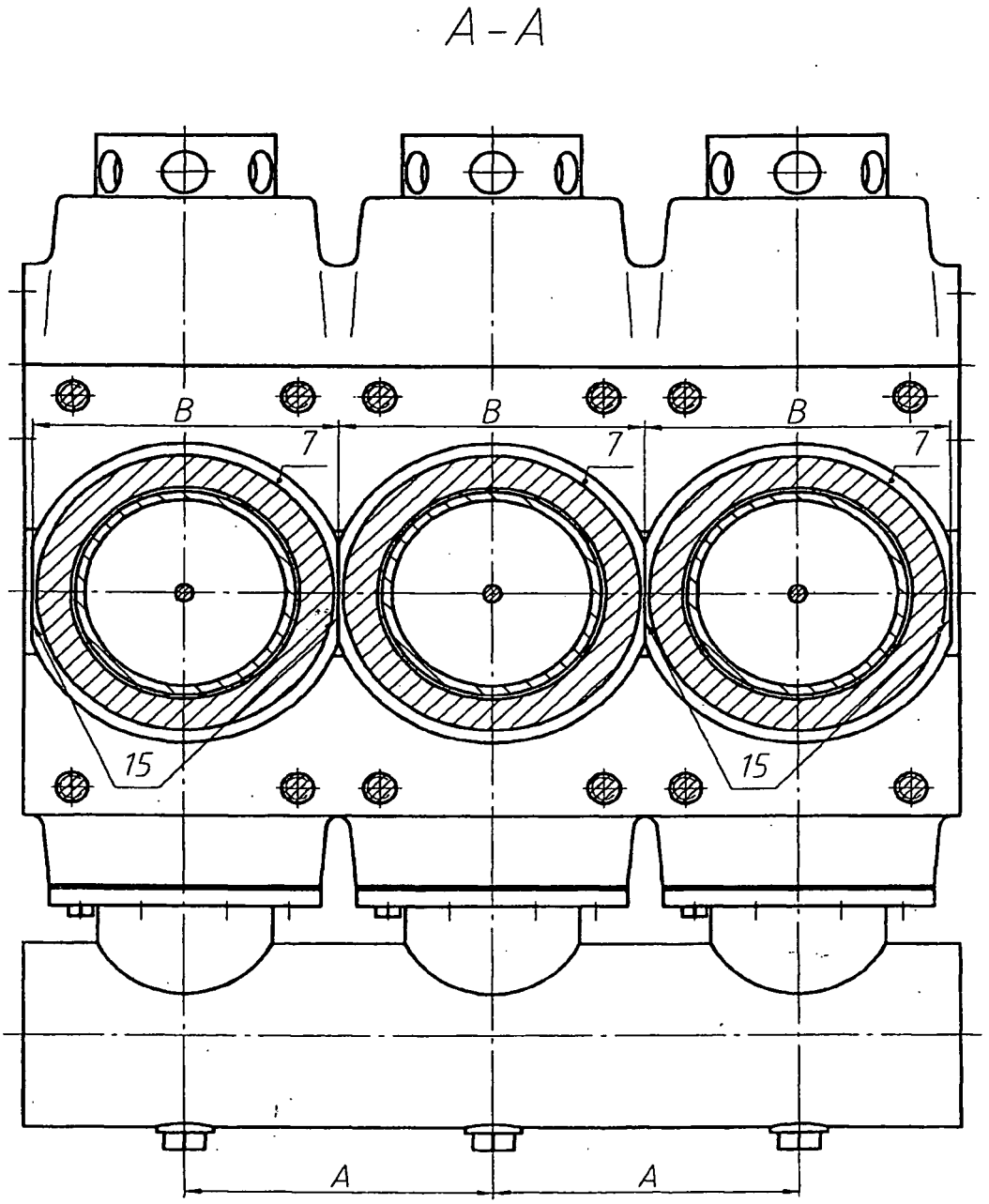

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2007/000468

A. CLASSIFICATION OF SUBJECT MATTER

F04B 15/04 *(2006.01)*
F04B 1/00 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B 15/00-15/04, F04B 1/00-1/02, F04B 3/00, F04B 9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

RUPAT, RUABRU, RUPAT OLD, Esp@cenet, PAJ, USTPTO DB, DEPATISNET

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 3276390 A (PETER S.BLOUDOFF et al.) 04.10.1966	1
A	SU 1312245 A1 (AZERBAIDZHANSKII NAUCHNO-ISSLEDOVATELSKII I PROEKTNO-KONSTRUKTORSKII INSTITUT NEFTYANOGO MASHINOSTROENIYA) 23.05.1987	1
A	SU 909276 A (G.V. VEIDEMAN et al.) 05.03.1982	1
A	SU 1751395 A1 (VOLGOGRADSKII ZAVOD BUROVOI TEKHNIKI) 30.07.1992	1
A	SU 1355757 A1 (E.I. GOROLEVICH) 30.11.1987	1
A	US 3891356 A (ARMCO STEEL CORPORATION) 24.06.1975	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 December 2007 (13.12.2007)	17 January 2008 (17.01.2008)
Name and mailing address of the ISA/ **RU**	Authorized officer
Facsimile No.	Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 3276390 A **[0006] [0007]**
- US 3891356 A **[0006]**

Non-patent literature cited in the description

- **V.A. Lesetsky ; A.L. Il'sky.** *Burovye mashiny i mekhanismy,* 1980, vol. VII.7, 206-207 **[0003]**
- **N.A. Severinchik.** *Mashiny i oborudovanie dlya bureniya skvashin,* 1986, vol. 113, 338 **[0003]**
- **R.A. Bagramov.** *Burovye mashiny I kompleksy,* 1988, vol. XIV.5, 251 **[0003]**
- **E.S. Ibragimov ; V.G. Gorbov ; V.F. Seryakov.** Nasosnyi agregat 4AN-700 dlya gidravlicheskogo razryva plastov I gidropeskostruynykh protsessov. *RNTS VNIIOENG, Machines and Oil Production Equipment series,* 1963, 9-14 **[0004]**
- **A.G. Molchanov ; L.G. Chicherov.** *Neftepromyslovye mashiny I mekhanismy,* 1976, 321 **[0004]**
- **E.I. Bukhalenko ; V.V. Vershkovoy ; Sh.T. Dshafarov et al.** *Neftepromyslovoe oborudovanie,* 1990, 258 **[0004]**